

---



# ***ADVANCING SURVEILLANCE TEST TECHNOLOGIES***



***CENTER FOR APPLIED ANALYTICAL TECHNOLOGIES TEST  
& EVALUATION DEPT.  
NSWC INDIAN HEAD DIVISION***

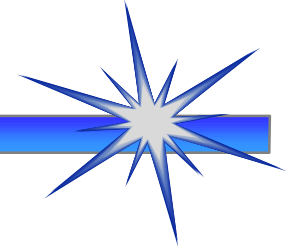


---

COMNAVSURFWAR CENDIV INDIAN HEAD MD / APPLIED ANALYTICAL LAB  
GAIL STINE DIRECTOR (301) 743-6521 GAIL.STINE@MAIL.IH.NAVY.MIL

| Report Documentation Page  |                                    |                                     |   | Form Approved<br>OMB No. 0704-0188                  |                                 |
|--|------------------------------------|-------------------------------------|---|---|---------------------------------|
| Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. |                                    |                                     |   |   |                                 |
| 1. REPORT DATE<br><b>AUG 1998</b>  |                                    | 2. REPORT TYPE                      |   | 3. DATES COVERED<br><b>00-00-1998 to 00-00-1998</b> |                                 |
| 4. TITLE AND SUBTITLE<br><b>Advancing Surveillance Test Technologies</b>   |                                    |                                     |   | 5a. CONTRACT NUMBER                                 |                                 |
|  |                                    |                                     |   | 5b. GRANT NUMBER                                    |                                 |
|  |                                    |                                     |   | 5c. PROGRAM ELEMENT NUMBER                          |                                 |
| 6. AUTHOR(S)   |                                    |                                     |   | 5d. PROJECT NUMBER                                  |                                 |
|  |                                    |                                     |   | 5e. TASK NUMBER                                     |                                 |
|  |                                    |                                     |   | 5f. WORK UNIT NUMBER                                |                                 |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br><b>Naval Surface Warfare Center,Center for Applied Analytical Technologies Test,101 Strauss Avenue,Indian Head,MD,20640</b>  |                                    |                                     |   | 8. PERFORMING ORGANIZATION REPORT NUMBER            |                                 |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)  |                                    |                                     |   | 10. SPONSOR/MONITOR'S ACRONYM(S)                    |                                 |
|  |                                    |                                     |   | 11. SPONSOR/MONITOR'S REPORT NUMBER(S)              |                                 |
| 12. DISTRIBUTION/AVAILABILITY STATEMENT<br><b>Approved for public release; distribution unlimited</b>  |                                    |                                     |   |   |                                 |
| 13. SUPPLEMENTARY NOTES<br><b>See also ADM001002. Proceedings of the Twenty-Eighth DoD Explosives Safety Seminar Held in Orlando, FL on 18-20 August 1998.</b>   |                                    |                                     |   |   |                                 |
| 14. ABSTRACT   |                                    |                                     |   |   |                                 |
| 15. SUBJECT TERMS  |                                    |                                     |   |   |                                 |
| 16. SECURITY CLASSIFICATION OF:  |                                    |                                     | 17. LIMITATION OF ABSTRACT<br><b>Same as Report (SAR)</b> | 18. NUMBER OF PAGES<br><b>17</b>                    | 19a. NAME OF RESPONSIBLE PERSON |
| a. REPORT<br><b>unclassified</b>   | b. ABSTRACT<br><b>unclassified</b> | c. THIS PAGE<br><b>unclassified</b> |   |   |                                 |

# OUTLINE ISSUES

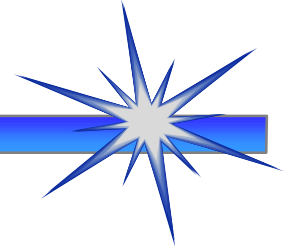


Naval Surface Warfare Center, Indian Head Division

- Background
- Current Surveillance Test Methods
- Solutions - The New Technologies
  - MEMS
  - Chemical Sensors
  - Embedded Sensors
  - Field Monitoring Miniaturized Instrumentation
- Challenges
- Progress to date
- Summary

# BACKGROUND / ISSUES

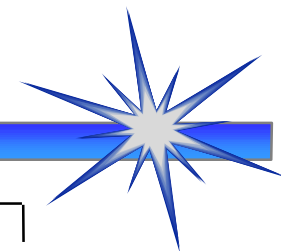
Naval Surface Warfare Center, Indian Head Division



- Safety - stability concerns
- Inventory control - throughout life cycle
- Performance/Reliability
- Service life predictions/extensions
- Waste management/Demil - Munitions Rule
- Full Life Cycle Management - O/S Cost Reduction

# SURVEILLANCE TEST METHODS

Naval Surface Warfare Center, Indian Head Division



## Thermal Stability Testing

- Oven Fume Test
- Differential Scanning Calorimeter (DSC)
- Accelerating Rate Calorimeter (ARC)
- Differential Thermal Analysis (DTA)
- Thermo-gravimetric Analysis (TGA) Tialiani
- Vacuum Thermal Stability
- Microcalorimetry
- Thermal cook-off

## Stabilizer Determination

- High Performance Liquid Chromatography
- Other Chromatographic methods (GCMS, LCMS, photodiode array)
- Capillary Electrophoresis
- Wet chemistry (Titration techniques)
- Supercritical fluid extraction & chromatography
- Robotics

## Other Tests

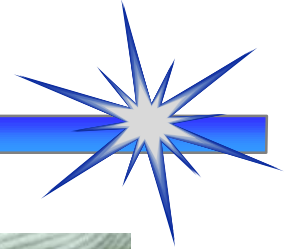
- Mechanical Properties
- Rocket motor performance
- Hybrid Tests (Aging + Stabilizer test)
- Gas analysis (FTIR, CG, etc.)
- Accelerated Aging Tests
- Chemical Migration Tests
- **Fiber optic/Spectroscopy**
- Chemical reactivity/compatibility
- **MEMS/Chemical Sensor**
- **Embedded Sensor**
- **Field monitoring MEMS Instrumentation**

## Modeling & Simulation

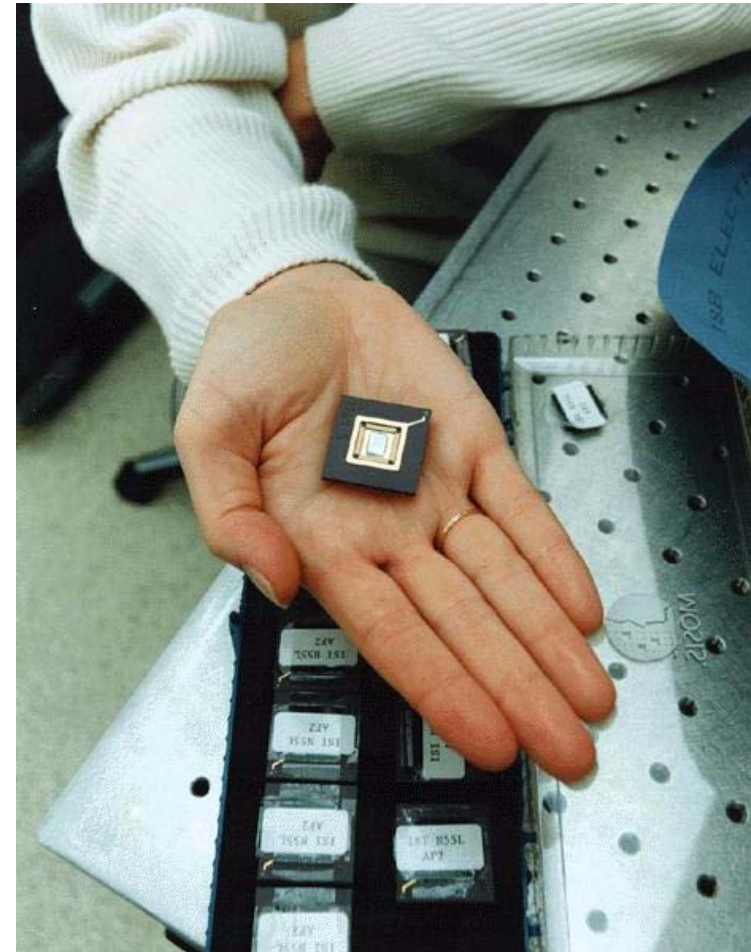
- **Service life prediction**
- Type life
- **Shelf life prediction**
- Kinetic analysis

# SOLUTIONS - THE NEW TECHNOLOGIES

Naval Surface Warfare Center, Indian Head Division

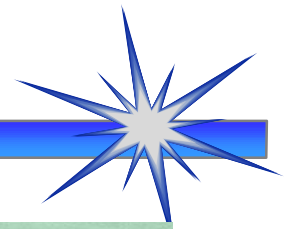


- MEMS
- Chemical sensors
- Embedded sensors
- Fiber optics
- Field monitoring - miniaturized instrumentation

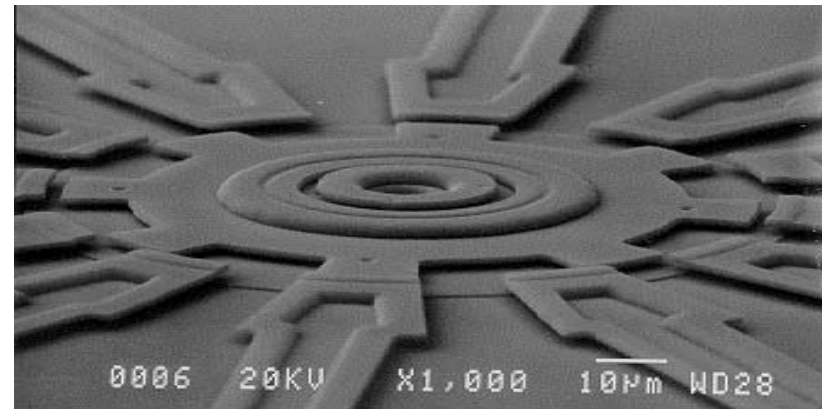
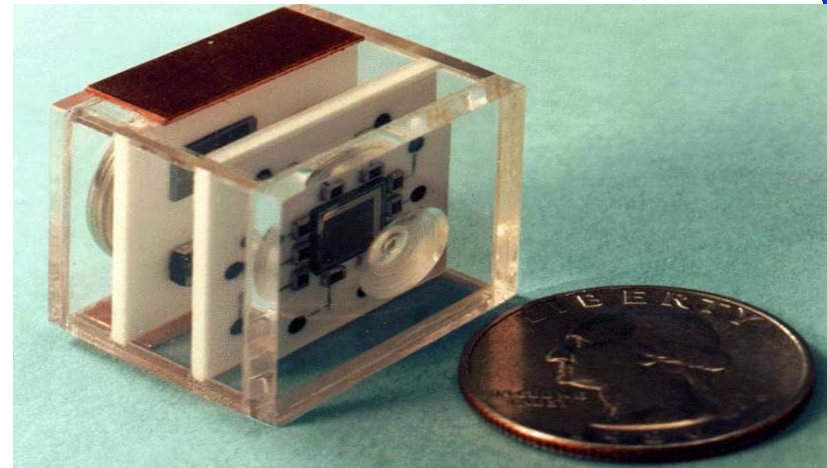


# MEMS: MICRO - ELECTRO - MECHANICAL SYSTEMS

Naval Surface Warfare Center, Indian Head Division



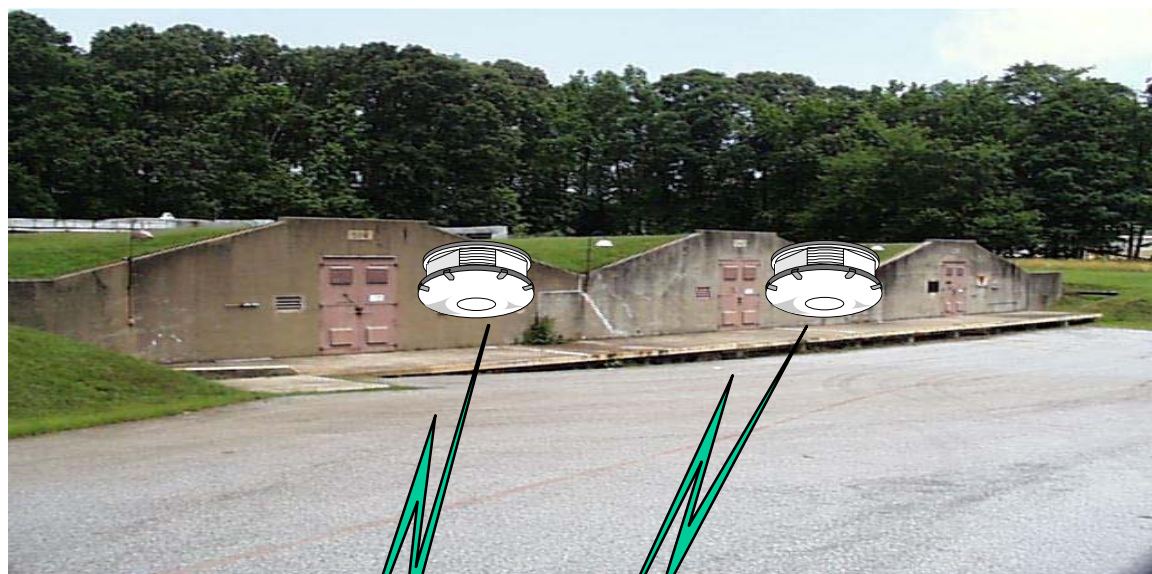
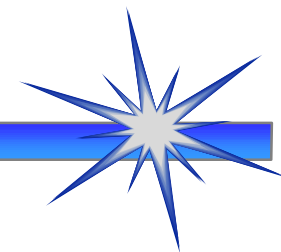
- Miniaturization plus multiple components plus microelectronics
- All components on a chip, dimensions measured in microns
- Uses and applications only limited by the imagination





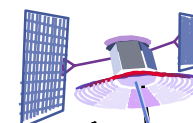
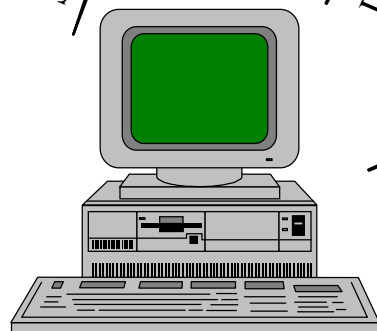
# MEMS INVENTORY MANAGEMENT SYSTEM

Naval Surface Warfare Center, Indian Head Division



Query  
Signal

Data  
Response



Satellite

Data:  
Inventory  
Temperature  
Chemical  
etc.

FLEET  
IMSD  
etc.

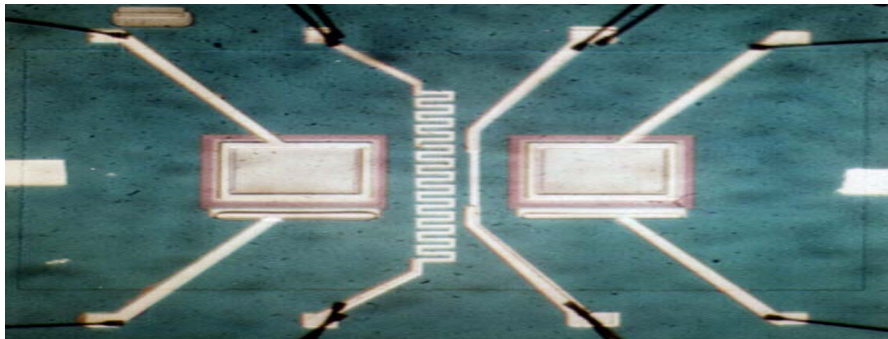


# CHEMICAL SENSORS

Naval Surface Warfare Center, Indian Head Division

## “IN SITU” Real Time Propellant Analysis

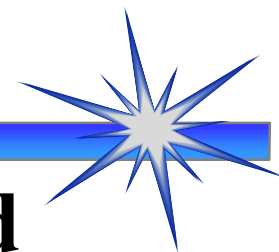
- Current technology: electro-chemical cells
- Future technology: molecular imprinted biosensors
  - add sensors serially to MEMS chips
  - potential for embedded applications
  - highly selective for chemical species, i.e., CO Vs  $\text{CO}_2$  Vs NO Vs  $\text{NO}_x$ , etc.



$\text{NO}_x$  SENSOR CHIP

# FIELD MONITORING MINIATURIZED INSTRUMENTATION

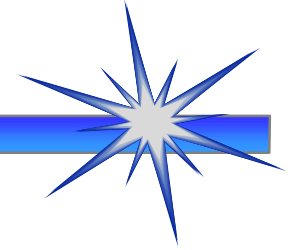
Naval Surface Warfare Center, Indian Head Division



## Bringing Surveillance to the Field

- Research —→ applications stage
  - UV, FTIR, NIR spectroscopy
  - Mass spectrometry
  - Chromatographic system (HPLC, IC)
  - Capillary zone electrophoresis
  - Fiber optic / spectroscopy
- Advantages :
  - > Reduces/eliminates shipping costs/transportation costs
  - > Non destructive / Non invasive
  - > Enhanced Safety
  - > Operational personnel may be able to perform
  - > Immediate results
  - > Cost reductions allow greater sample size (statistical validation)

# CHALLENGES

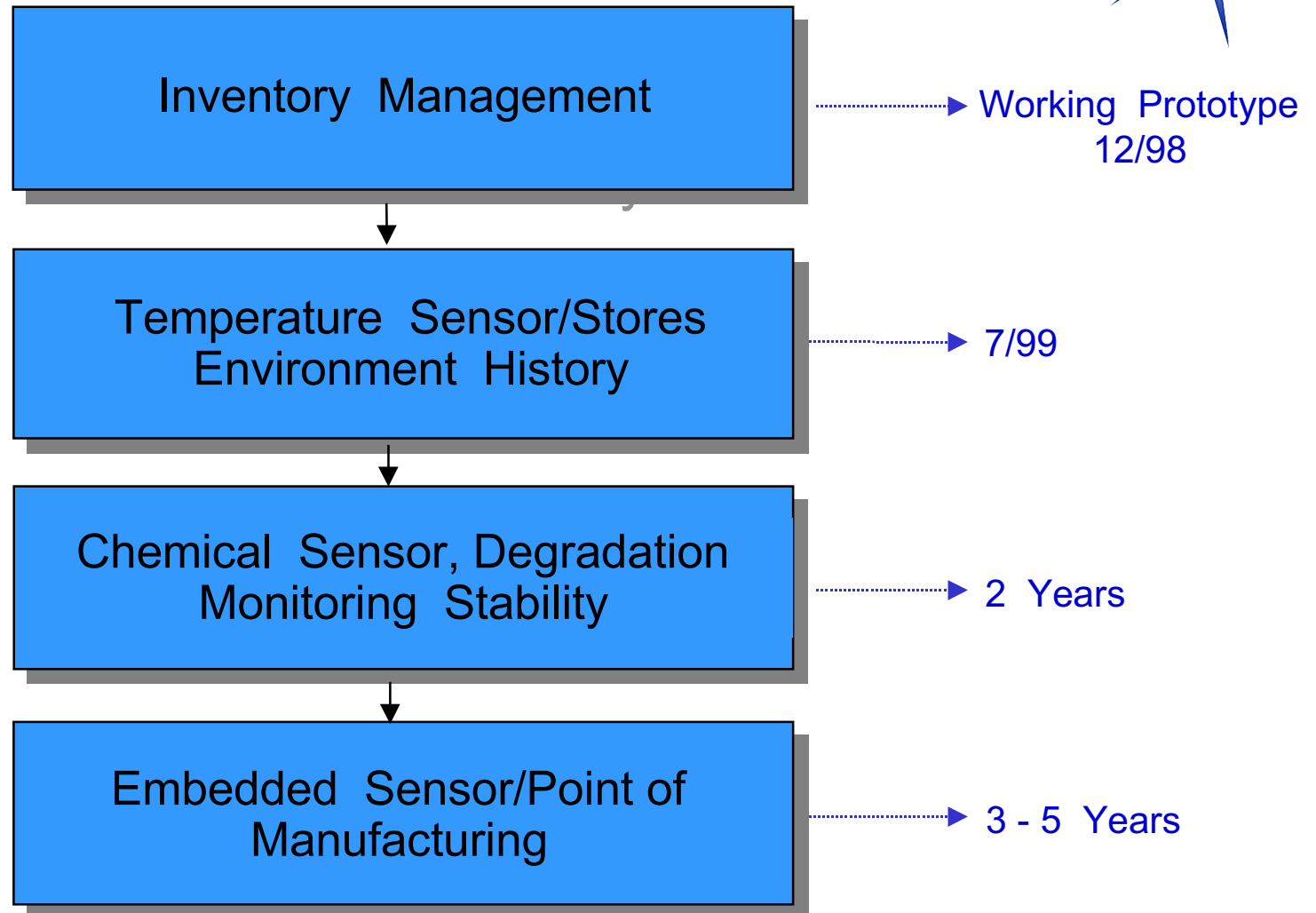
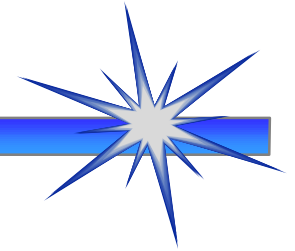


Naval Surface Warfare Center, Indian Head Division

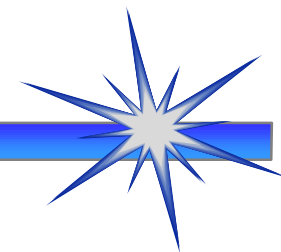
- More Engineering than R&D
  - Power issue
- Integration of sensors to MEMS devices
- Hazards (HERO, physical presence, RF interference, etc)
- Integration into weapon (mft & logistic issues)
- Correlation of chemical sensor data to safe shelf-life
- Pace of Technology advances

# CHALLENGES (Cont)

Naval Surface Warfare Center, Indian Head Division



# PROGRESS TO DATE



Naval Surface Warfare Center, Indian Head Division

- Predictive Technology Symposium - Nov 97
  - ARDEC & NSWCIIHDIV co-host follow-on workshops  
Dec 97/May 98
- Surveillance & Predictive Technology  
Program established at NSWCIIHDIV (Jan 98)
- Briefings given:

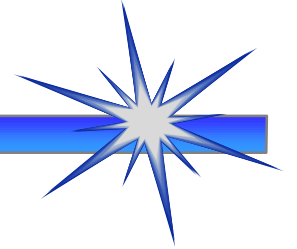
OSD  
CINCLANTFLT  
CINCPACFLT  
NAVSEA  
O/EDCA  
OPNAV (N4)

ARDEC  
DDESB  
NSWC  
MARCORSYSCOM  
NAVORDCEN  
MCPD FALLBROOK

NAVSUPSYSCOM  
NAWC CHINA LAKE  
PACIFIC NORTHWEST  
NATIONAL LAB  
SECNAV

# PROGRESS TO DATE (CONT)

Naval Surface Warfare Center, Indian Head Division

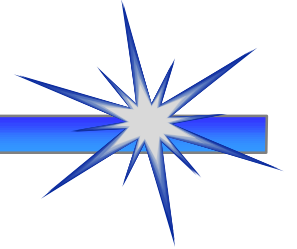


- Prototype development
  - ✓ Inventory MEMS by 1st qtr FY99
  - ✓ Sensors (Temperature) by 3rd qtr FY99
- Proposals
  - ✓ Navy AIT
  - ✓ PMS 422
  - ✓ PM Crusader
  - ✓ Naval Explosives and Weapon System Safety Program
  - ✓ CNO N86/N88 RDT&E for QE Application



# PROGRESS TO DATE (CONT)

Naval Surface Warfare Center, Indian Head Division



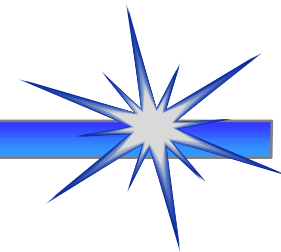
## Crusader Program

- Propelling Charge Identification
- Temperature Sensor
- Integration with Fire Control Computer



# PROGRESS TO DATE (CONT)

Naval Surface Warfare Center, Indian Head Division

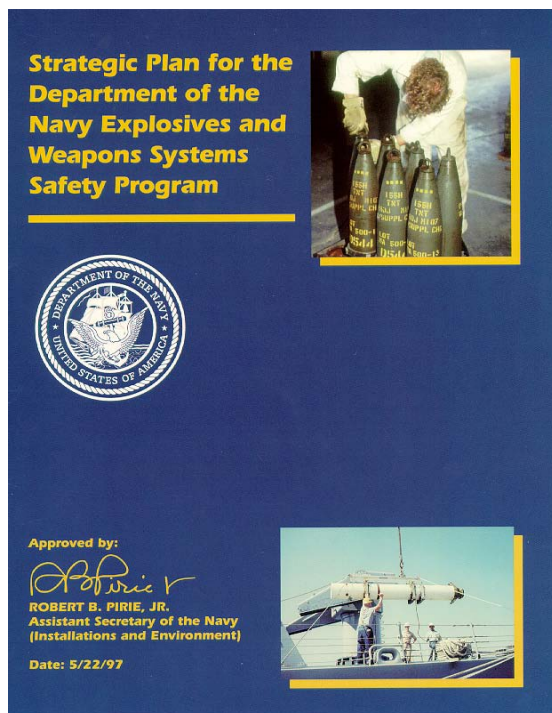


## DON Explosives & Weapons System Safety Program

- 1997 Plan will advance explosives safety through six strategies
  - Strategy #3 Technology

*NSWCIHDIV has submitted six proposals:*

- MEMS applications for real time monitoring
- MEMS sensor prototyping with communication media
- MEMS as Safe & Arm devices
- Field monitoring with miniature analytical instruments
- Computer modeling of safety characteristics
- Correlation studies for future tests



# PROGRESS TO DATE (CONT)

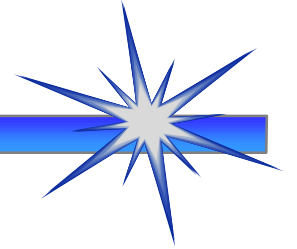
Naval Surface Warfare Center, Indian Head Division

## PMS 422 Seatask (Temperature Data Logging)



- Temperature data logging
- Chemical aging analysis and modeling

# SUMMARY



Naval Surface Warfare Center, Indian Head Division

- Sensor Technology progressing rapidly
  - applications limited mainly to imagination
- MEMS/Sensors major thrust at NSWC IHDIV
- Interest building Navywide
- Leveraging / teaming essential